

NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-Annual Report

October 1955

GENERAL

I'm not sure we got so much done the past six months--but we were awfully busy. Sid Weitzman labored along without a Project Leader until Ken Reinhart's recent arrival at the Fernow. At Kingston, Reigner and Eschner were bedevilled by drought, fire, and flood, in that order. Trimble's group at Hubbard Brook enjoyed their first field season on their new Experimental Forest. An enjoyable memory is the breath-taking dip with Storey, Wilm, Trimble, and Sartz into one of the deeper and colder pools of Hubbard Brook.

New Jersey Study

In April, we started weekly measurements of soils moisture content under five stand conditions at the Lebanon Experimental Forest. The soils are deep and sandy--mainly Evesboro sand; the five conditions included oak scrub, herbaceous, mature shortleaf pine, pine saplings, and pine reproduction. Soil moisture records will be interpreted in terms of opportunity for groundwater recharge. Samples have been taken with a soil tube to a depth of 5 feet with occasional forays to 11 feet. Sampling will end this winter after soil moisture recharge.

Northern New Jersey Watersheds

In May, Si Little and Lull paid a visit to East Orange's Water Reserve and Newark's Pequannock watershed. East Orange has a 2,200-acre Reserve in which it draws water from deep wells--over 5 million gallons a day. The Reserve, which is almost entirely forested, has an intensive fire protection system and management plan. Recharge areas have been developed over gravel and sand beds.

Newark utilizes all the streamflow from their 36,000 acre Pequannock watershed. Five reservoirs occupy about 2,000 acres. The watershed furnishes about 50 million gallons of water a day, about half of Newark's requirements. Watershed management involves largely protection: water value is dominant and sales of forest products are not encouraged. A three-man crew is kept busy cutting streambank vegetation and clearing channels to prevent coloration of water by decaying wood.

Water shortage is the major problem of this metropolitan area. According to one authority, the safe yield of underground and surface supplies for northern New Jersey is 480 million gallons per day; present withdrawal is 485 million gallons. Foresters in charge of both the East Orange and Newark watershed are keenly interested in methods of increasing yield. They are now considering our suggestions for yield and protection studies.

Appreciation

In getting Hubbard Brook underway, we have often sought the advice of others in setting up a program. Responses to our queries have been most generous. We have talked with Dick Hertzler, Howard Cook, Walter Langbeim; Hal Wilm kindly agreed to serve as a Station consultant and recently spent a week at Hubbard Brook; we have had two excellent memoranda from Henry Anderson and Ed Johnson concerning sedimentation and groundwater measurement, and have had correspondence with Jerry Dunford, Bert Goodell, and Marvin Hoover on streamflow and precipitation measurement. And, Herb Storey has been steadily pitching for us--for these and sundry other favors--our thanks.

Quotes:

Rushmore and Ash Hough have brought the following two timeless references to our attention:

"There is great need of streamflow records in order to discuss intelligently the effects of forest upon river flow, for while it is generally recognized that forest preservation has a beneficial influence, the extent of this influence has never been accurately determined, and there is wide diversity of opinion as to how far-reaching it is. On hardly any phase of forestry has there been more discussion than on this, and on hardly any is there so slight a basis of known fact on which to rest the argument. It is very necessary that a definite understanding be reached on this point, for on the available supply of water depend many of the greatest industries of the country."

Frederick H. Newell. Bull 30.
Div. of Forestry, USDA 1901

"The important fundamental rule to be observed in the location of a forest road is, the grade should always be an easy one. A long road is safer, cheaper, and better than a steeper one.These roads should be properly ditched on the sides....and the breaks for the removal of water should not be more than 100 feet apart on an ascending road."

"The decreased flow of streams in Pennsylvania, the great demand made upon them for manufacturing purposes, and the pollution to which they are subject by reason of the increase of population and the multiplication of industrial establishments, are such unnatural conditions that it became necessary to devise some means by which the water supply might be made cleaner and more abundant, and kept so, as far as possible."

Report of the Pa. Dept. of Forestry, 1907

KINGSTON RESEARCH CENTER

The situation developed slowly at Dilldown. It rained now and then early in June and almost 2 inches on June 11 and 12. After that, the dry season began. The rest of June saw 0.34 inch of rain. By July 15, 0.11 more rain had fallen. On that day, Dixon Miller found the first fire on the watershed. A week later, with no more rain, but with plenty of heat and low humidity, the trouble began. The incendiary, apparently well informed, picked the hottest day of the summer to set three more fires on the watershed.

The Pocono Experimental Forest, although not exactly one of God's more favored spots, fared somewhat better than Dilldown. Only 16 miles away, and with a consistent record of 20 percent less rainfall than Dilldown, it was a little better watered in July. During the same time that 0.11 inch trickled on Dilldown, 1.87 inches of rain fell on the Pocono Forest.

It finally did rain, though, and not gently. Hurricanes Connie and Diane were blown out but not dried out by the time they reached the Poconos. Within seven days, the two hurricanes dumped 15.29 inches of rain on Dilldown and 19.98 inches on the Pocono Forest.

More later on the flood, but first:

The Fire

Smoke was first sighted by Gene McNamara on the afternoon of July 22. He called for help and went to the smoke. By the time help arrived, two more sets had been discovered, and none could be extinguished. The soils had become so dry that roots and stumps burned under-ground, smoldered indefinitely, and carried the fire to unburned areas. Even the humus at Dilldown, peculiarly fireproof, burned in some spots and exposed mineral soil.

The next day, Saturday, another fire was set, this time in the adjacent watershed of Mud Run Creek where most of the experimental plantings are located. Although the Penna. Dept. of Forests and Waters had numerous crews and bulldozers at work, considerable areas burned at all sets and lines could not be held. The local fire company responded to call and managed to save several buildings in the path of the fire. Finally, a bulldozer managed to get a line around the Dilldown fire about sundown.

That night it rained--all of 0.04 inch (0.73 at the Pocono Forest). Although the fires were not extinguished, even this slight amount allowed the crews to contain the fires.

Then began the exhausting task of patrolling--trying to hold the fires until enough rain fell to extinguish them. State crews from three districts made up the bulk of the manpower; but considerable support was given by leaders and older boys of three Boy Scout camps in the vicinity. This center rendered the small amount of assistance it could.

The monotony was punctuated by another set at the far end of Mud Run watershed on the sixth day, a shift in wind on the ninth day which carried the Mud Run fire to new areas, and the sixth set on the eleventh day.

A brisk wind on the twelfth day carried the Dilldown fire across its line and burned about 300 additional acres of the watershed before a new line could be bulldozed. Burning conditions were so bad by this time that the fire travelled swiftly even at night if fuel were available.

On the thirteenth day, the seventh set was discovered, near the stream-gaging station. Conditions were so desperate that Mike Ostrander and Wayne Banks from our Upper Darby office were dispatched to the fire and two men from the Allegheny National Forest arrived with a truckload of equipment on the fourteenth day.

These fellows had the right touch and brought 0.04 inch of rain on the fifteenth day, followed by 0.68 on the sixteenth day. The situation was good by then, and the fire was finally extinguished the following day, August 7, by more showers totalling 0.92 inch.

While the fire was quite small in comparison to western fires and the actual monetary damage was negligible, still the suppression costs were considerable, and the future of our watershed research is discouraging when the incendiary situation can be solved. Extremely dry summer conditions such as those experienced this summer are rare, probably occurring about once every 25 years. Fortunately, this fire came at the end of the calibration period.

The Flood

During the fire, it was often predicted that when the drought was finally broken, it would REALLY rain. How true!

The Friday after the fire, Hurricane Connie hit the Poconos. Rainfall at Dilldown totalled 9.06 inches; at the Pocono Experimental Forest it amounted to 8.33. This was an exceptionally large storm but no damage was experienced because the soil was so dry and groundwater so low that much of the rain could easily be stored.

But storage capacities were filled by Connie and along came Diane on the following Wednesday. Diane was a smaller storm at Dilldown, amounting to 6.23 inches of rain. Stream discharge, however, rose to a record height, somewhere close to 350 c.f.s. (146 c.s.m.). This was almost double the previous high discharge, the result of 9.30 inches of rain in July 1952. The damage at Dilldown was not great; roads suffered some washouts and a new emergency fire line eroded badly and carried some sediments toward (but not into) Dilldown creek.

The situation at the Pocono Experimental Forest was amazingly different! Connie was smaller, 8.33 inches and resulted in greater runoff than at Dilldown--apparently because the watershed has less storage capacity. But, Diane hovered over the Experimental Forest and dumped 11.65 inches; this was the high measurement for Pennsylvania according to Weather Bureau correspondence just received.

The peak stage at the streamgaging station was about 1.5 feet over the wing walls of the weir. Several small dams in the vicinity were breached and further downstream much damage was done.

The Stroudsburg disaster, well known to all, was the result of Diane's downpour on the eastern Poconos. The Broadhead Creek watershed, which delivered the damaging flood waters to the Stroudsburgs, is nearly all forested. A few days after the storm, sitting on one of Hazel's windfalls in the Pocono Experimental Forest, we looked at water-windrowed leaves under a sixty year old stand and mulled over our ideas of flood control. Certainly, forested watersheds will not prevent floods from storms of Diane's magnitude.

Watershed Calibration

Between the foregoing diversions and other sundry odd jobs developing from them, we have attempted to carry on our watershed calibration analysis. Several items of interest were discovered. To begin with we analyzed the relationships between annual precipitation and runoff, using raw data uncorrected for storage changes. Beginning the water-year of each of the 12 months, some of the correlations were remarkably high. The best correlation was obtained for the year beginning July 1, with a correlation coefficient of 0.995. Groundwater storage varied less on June 30 than at any other month end.

Later, after calculating the storage amounts (soil, groundwater, and snow) for each month end, we were able to determine an adjusted annual runoff for all years and beginning with each calendar month. That is, we have adjusted runoff for each year beginning January 1, for each year beginning February 1, and so on. With 6 complete years of data, we have 61 annual periods to work with.

Adjusted runoff for each period was plotted on a time scale, resulting, in effect, in a 12-month running average of runoff. When 12-month running averages of the various independent variables were plotted on the same time scale, relationships were easily discernible. Precipitation was closely correlated, as may be expected.

The effect of precipitation was removed by calculating the deviations from an equation using adjusted runoff as the dependent variable and precipitation as the independent variable. The deviations were plotted on the same scale and another pattern developed. This one showing a similarity with a plotting of saturation deficit.

A multiple regression was then calculated with saturation deficit showing up highly significant. The deviations from this regression still form a pattern which is not random variation.

A start was made to relate peak discharge to other measurable variables. An excellent relationship was obtained using simple storm precipitation. The relationship was improved by using the increase in discharge (peak discharge minus discharge at beginning of storm). The analysis has not progressed far, but it appears that antecedent precipitation will be a factor.

Streamgaging Station Maintenance

For some time we had been anxious to remove the sediment in the weir pool at the Pocono Experimental Forest. Actually the sediment was not great and was mostly light organic matter. Before we got to the job, however, Diane came along with a rather large amount of heavy sediment--rocks, gravel, and sand. Diane also upset an 800 pound concrete pillar which held the outside staff gage.

The weir, built in 1949, had never before been drained and we anticipated trouble in removing the drain plugs. The latter were threaded cast iron plugs turned into the downstream ends of the drain pipes. Much to our surprise, they were easily removed. We can highly recommend this arrangement; the plugs are very accessible, making the job of draining the pool quite simple.

The sediments were cleared from the pool and the gage pillar was reset with a new footing poured around it. At the same time a slab was installed in the streambed below the weir to facilitate current meter measurements.

A similar job must still be done at the Dilldown weir. The U.S.G.S. hydrographic engineers who generally furnish maintenance to this weir are swamped with repair work from Diane. We have volunteered to do the job.

Dilldown Report No. 3

April and May were devoted to preparing the third biennial report on the Delaware-Lehigh Experimental Forest (Dilldown Watershed). Although changes in personnel and center location precluded much analysis of piled up data, the report will include the usual climatic, groundwater, and streamflow tables, completing six years of published records. Also presented are discussions on each of the hydrologic factors and a detailed progress report on the scrub oak conversion studies at the Experimental Forest.

The publication has been edited and presented to the Pennsylvania Department of Forests and Waters for approval and publication.

Scrub Oak Conversion

Some years ago, we wrote a Station Note relating how we planted seedlings too soon after treating the site with herbicides and all or most of the seedlings died. We're in a rut--it happened again!

Spots treated with herbicides on March 10 and 11 were planted with red pine on May 9 to 12. We figured that two months should be plenty of time for the toxicity of the herbicide to be dissipated. We were primarily interested in growth, not in survival, but made provision to test for residual toxicity.

Sure enough, it is quite clear that the spots showing the best kill of the unwanted ground cover also have the fewest survivors. The heavy Ammate concentrations have fewer survivors than the lighter concentrations, and spots prepared with 2,4,5-T both in oil and water carriers have low survival rates. We will report more completely on this matter later.

Dilldown Conversion Plan

A plan for conversion of the scrub oak cover to tall-growing tree species was prepared by W. E. McQuilkin in July for the consideration of the Pennsylvania Department of Forests and Waters. The plan has been tentatively approved, pending discussion of planting schedules, and work will begin this fall on mechanically clearing 335 acres for planting next spring. As constituted, the plan entails a 5-year planting program to convert 1140 acres of the 1530-acre watershed.

Infiltration Project

Field work in the Northeast for the Vicksburg Infiltration project was completed in June. However, even before the end was in sight, Ralph Moyle was transferred to the Crossett Experimental Forest in Arkansas. Forestry aid Johnnie Lee, from Vicksburg, Mississippi, was detailed to Kingston for six weeks to assist in the final sampling rounds.

Soil identification at all sites in Pennsylvania, New York and New England has been completed with the cooperation of soil scientists of the S.C.S. in their various districts. Some of the physical properties of these soils have been determined and are to be published or otherwise made available to these cooperators. Eschner is attempting to correlate bulk density of soil with other, more easily measured, physical characteristics of the soil in an effort to make bulk density determination simpler.

Three additional study sites were set up on the University of Maine forest near Orono in cooperation with the Penobscot Research Center. These sites were visited twice by personnel of the infiltration unit and will be sampled daily for the rest of the summer by student assistants from Maine.

Upon completion of the field sampling schedule early in June, Johnnie Lee and Beryl Jones left for Vicksburg. Art Eschner remains at Kingston as a member of the center's staff.

Meetings

The Pocono Forestry Association annual meeting was attended August 17. The panel on "Forest Problems and Answers" revealed the increased pressure on forest land for flood control, hunting, fishing, timber production and scenic enjoyment. An additional \$500 was voted for conviction of those setting forest fires maliciously thus bringing the reward to \$1,000 in the Pocono region.

A series of meetings sponsored by the Pennsylvania Forestry Association have been scheduled to initiate the formation of local watershed groups. The program envisages several regional groups which will be subdivided into local watershed groups. The Brandywine Valley Association, with a successful ten-year record, is used as a model.

Howard and Reigner attended the second of the series, held in Stroudsburg on September 21. It was a very timely subject, coming so soon after the recent flood disaster. Many of those attending were under the impression the meeting was called to discuss the flood. Instead, it was a segment of a long-range program.

The same day, Howard and Reigner attended the first session of the Congressional Subcommittee hearings on the Hoover Report on Water and Power Resources. The sub committee will hold hearings in all regions to receive testimony from the citizens and organizations in those regions. Although a number of the witnesses were not familiar with the Hoover Report, general agreement was reached that the Middle Atlantic states have not been receiving their share of Federal expenditures for flood control. On other, more controversial issues, no agreement was reached.

MOUNTAIN STATE RESEARCH CENTER

Calibration is continuing on the five watersheds in which weirs were constructed in 1950. Plans have been made and sites selected for two new 120° V-notch weirs to be built this fall.

Representatives from nearly all the National Forests in Region 7, as well as many other public and private foresters, have by now visited the Fernow Forest to study truck and logging-arch road construction. Most have been impressed with the fact that even in steep country, it is not only possible but practicable to lay out roads with a grade of only 10 percent.

Visitors

The popularity of Weir No. 2 is growing by leaps and bounds. Visitors from as far away as Africa dropped in on us. In all, during the past 6 months we conducted 22 show-me trips involving over 225 visitors. Included were 50 Forest Service visitors, from both NFA and Research.

Meetings

Sid Weitzman attended the Supervisors' meeting, Region 7, and delivered a paper on "Integrating Timber and Watershed Management".

On September 23, Weitzman and Hutnik attended the West Virginia Chapter meeting of the SAF at Camp Caesar.

On September 24, Weitzman attended the S.C.S.A. meeting at Jackson's Mill, where he presented a paper on "Woodland and Watershed Management under West Virginia Conditions".

Personnel

Ken Reinhart left the hot Mississippi country-side and arrived over the Labor Day weekend; so the position vacated by Dick Trimble in October 1954 has finally been filled. Ken was previously with the Vicksburg Infiltration Project and is in the process of getting his feet wet in local watershed management problems.

WHITE PINE-HARDWOOD RESEARCH CENTER

The Hubbard Brook watershed was officially established as an Experimental Forest on May 17, 1955. The entire Hubbard Brook drainage has been explored in detail. Every foot of streambed has been examined for good gage sites. The condition of the cover and the boundaries of the subwatersheds have been looked into. Dick Sartz, who bore the brunt of this exploration, lost so much weight he now answers to the name of "Skinny".

Soil Survey

Field work on the soil survey of the Hubbard Brook Experimental Forest has been completed except for writing a few more profile descriptions. A joint report will be made with the Soil Conservation Service. Bob Pierce and the SCS surveyors are working up a soils map for the area.

Skid Road Revegetation Study

A skid road revegetation study was installed on the Bartlett Experimental Forest in August. The following seed mixtures are being tested--with and without lime and fertilizer treatment--on both badly eroded and slightly eroded abandoned skid roads:

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|-------------------|---|
| (1) Barn chaff | (4) Oats, timothy, and red top
(equal portions by weight) |
| (2) Rye | (5) 44% red fescue, 20% Kentucky blue
grass, 20% red top, 12% domestic
rye, 4% White Dutch clover
(portions by weight) |
| (3) Orchard grass | |

Installations

A 90 degree V-notch weir has been installed on one of the Hubbard Brook subwatersheds. Precipitation measuring stations and a climatic station are also being installed. Considerable time will be devoted to winterizing the equipment and determining methods to use in measuring both runoff and precipitation during periods of extremely cold weather and heavy snow.

Hurricane Diane

Sartz and Trimble made a reconnaissance of flood damages in southwestern Massachusetts and northwestern Connecticut resulting from the heavy rainfall that was caused by Diane. From 10 to 20 inches of rain hit the area. Damage from flooding was terrific. Our survey was aimed at determining what happened in the wooded areas. We looked for evidence that man's activities--land use practices--had affected damages.

It was strikingly apparent that roads were the primary cause of erosion and sedimentation from wooded areas. All of the poor road practices we have preached about were evident and the results were startling. Steep, undrained roads gullied and washed, dumping tons of earth and rocks on highways, and in streams and ditches. Poorly located roads--roads too close to streams or which approached stream crossings from below or which were located in draws--became raging torrents as streams jumped their banks and washed out the road beds. Culverts and bridges--too far apart or of too little capacity--plugged or washed out. On the other hand, the few good woods roads we saw appeared to have stood up reasonably well, considering the ferocity of the storm. Good locations and adequate drainage provisions paid off. Another noticeable fact was that well vegetated old road beds, banks, and shoulders eroded little under heavy surface runoff except where they were hit by a head of water. Earth slides were frequent along both streams and roads on very steep slopes--even in places which were well forested. Stream bank cutting and scouring happened frequently; it appeared to be especially prevalent where the stream banks had been encroached upon by roads. On some very steep forested slopes--on grades above 65 percent--there was some evidence of overland flow even where the forest floor was in good condition.

In addition to serving as source areas of sediment, the poor forest roads undoubtedly acted to concentrate runoff, thus aggravating the flood situation.

Snow Study

Results from the snow study at the Bartlett Experimental Forest, described in the last semi-annual report, are as follows:

1. The interception of snow (in terms of water equivalent) by a bare hardwood canopy was confined largely to the area beneath the crowns. In openings in the forest, the interception effect was not felt beyond a distance between 5 and 20 feet from the edge of the canopy, and even within this variable belt it was slight.

2. The snow pack in the open contained the greatest amount of water. Pole-sized hardwood stands intercepted more snow than sawtimber stands. Average accumulated interception of snow water (at time of maximum snowpack) in pole stands was about 10 to 12 percent. Sawtimber stands intercepted about half as much water as the pole stands.

3. Density of the snow under the hardwood canopy was consistently greater under both pole and sawtimber stands than in the open at maximum snow pack. This difference persisted well into the melt period.

4. Snow disappeared first in the unshaded open; next under canopy; and last from a narrow shaded belt near the southern boundaries of the plots; i.e., in the open near the north edge of the timber. This resulted from the higher accumulated snow water in the open and the lower rate of melt due to shading from the nearby forest canopy.

5. The snow pack apparently began to lose water by melting when the snow density reached about one-third or when 3 inches of snow contained about one inch of water.

6. Snow melt at the tree trunks extended in ever-widening circles of bare ground as the melt period progressed.

7. This study indicated that to catch the maximum amount of snow and to delay its melt as long as possible, narrow openings running in an east-west direction should be made. The most effective width of the cuttings would depend on latitude, aspect, grade of the land, and height of the trees. These factors affect the angle of incidence of the sun's rays and the amount of direct solar radiation reaching the snow surface. On steep north-facing slopes in tall timber, relatively wide strips could be used effectively. On 10 to 15 percent north-facing slopes with 60- to 70-foot high trees, a strip about 30 to 40 feet wide appears to offer enough shade to delay snow melting beyond the time snow disappears in both the unshaded open and under canopy. These figures are tentative; more study over a longer period would be necessary to establish firmer relationships.

Soil Freezing Study

Bob Pierce, Howard Lull, and Herb Storey have completed a rough draft of a manuscript on soil freezing which summarizes two winters' field work in the Northeast. The field work was done under the direction of Herb Storey when he was with the Station. The manuscript shows the effect of various types of forest cover and conditions on the occurrence and depth of impermeable soil freezing.

Bob Pierce will present a paper at this year's Eastern Snow Conference covering the highlights of the frost study manuscript.

Meetings

Jensen and Trimble attended the annual meeting of The Connecticut River Watershed Council at Amherst, Massachusetts in April. Trimble participated in a panel discussion on watershed management research with Lull and Wilm.

Jensen and Trimble attended the first meeting of the New England Watershed Conference in Peterborough, New Hampshire in August. Emphasis was on water scarcity and conservation. Ironically enough, the hurricane Diane floods struck during the conference--"food for thought".

Visitors

Les Harper, Ralph Marquis, and Chick Mattoon were Forest Service visitors at the Hubbard Brook Experimental Forest this summer.

Ed Johnson dropped in but we are sorry to say we were too deep in the woods for Ed to find us.

Bud Foster, secretary of the Connecticut River Watershed Council, was up for a visit.

A week-long program planning conference was held in July at Hubbard Brook. Participating, along with local personnel, were Hal Wilm, Herb Storey, and Howard Lull. This was a most helpful meeting.

PUBLICATIONS

Watershed Research Begins in New Hampshire by George R. Trimble, Jr.
Forest Notes 46:22-25. Summer, 1955.

Skidroad Erosion--A Byproduct of Mechanical Logging by Richard S. Sartz,
Northeastern Logger 4 (1):10-11. 1955.

Water Supplies and Our Forests by Howard W. Lull. Pennsylvania
Forests 45 (3):58-60. Summer, 1955.